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CRACKS INVESTIGATION OF BASEMENT AND THEIR MAINTENANCE IN HIGH-RISE BUILDINGS

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ABSTRACT

High-rise building crack formation is a serious problem that affects the stability and safety of these structures. In addition to examining the methods and approaches that might be utilised to address this issue, this thesis also investigates the causes and consequences of fracture formation in high-rise structures. To determine the size and severity of cracks in high-rise buildings, this study employed laboratory testing and field surveys. The effectiveness of various mitigation procedures is assessed, including strengthening and repair methods as well as preventive steps that can be done during the design and construction phases. The findings of this study suggest that high-rise building crack formation is a major and pervasive issue that calls for immediate and ongoing attention. According to the research, preventative measures like quality control and rigorous adherence to building rules can significantly reduce the likelihood of fracture formation in tall buildings. The subject of fracture formation in high-rise buildings is thoroughly examined in this thesis, including its sources, effects, and possible solutions. The study backs up the requirement for ongoing efforts to prevent and address this problem in the creation of secure and long-lasting high-rise structures.

Keywords: *Severity, mitigation strategies, crack formation, high-rise buildings.*

1 INTRODUCTION

The increase in popularity of high-rise buildings has led to an increase in the frequency of cracks appearing in these structures. These cracks can range from minor surface cracks to major structural damage, and they can compromise the safety of the building and its occupants. The causes of such cracks can vary, including factors such as poor construction methods, structural design flaws, and environmental factors.

- This study investigates the "causes, types, and consequences of cracks in high-rise buildings and proposes recommendations for detecting, preventing, and addressing these cracks to ensure the safety of occupants and the longevity of the buildings."
- As such, it is essential to study this issue to prevent future cracking and ensure the safety of high-rise buildings.

- There are several types of cracks which exist in the structure from the time of construction and afterwards too. So, the basic need to prevent them is to understand the type of crack generated in the structure.
- Cracks in high-rise buildings pose a serious threat to both human life and property. The damage caused by cracks in buildings can range from minor cosmetic issues to major structural damage that can result in the collapse of the building. Therefore, it is crucial to find effective solutions to prevent the occurrence and minimise the impact of cracks in high-rise buildings.
- This research aims to identify the causes of cracks in high-rise buildings and to evaluate the effectiveness of different techniques to prevent and repair them.

1.1 Objective of Paper

1. To pinpoint the root causes of cracks in tall buildings and examine how they affect structural integrity and safety.
2. To investigate the different kinds of cracks that are frequently seen in high-rise structures, as well as the reasons that lead to their growth.
3. To assess the efficiency of various crack detection and monitoring techniques and suggest the ones that are best suitable for high-rise structures.
4. To suggest the structural ramifications of cracks in high-rise structures and investigate various repair and maintenance techniques to lessen their impacts.
5. To examine case studies of high-rise structures with crack problems and make conclusions for bettering high-rise structure design, construction, and maintenance.
6. To create a thorough framework for managing cracks in high-rise structures that incorporates best practises from a variety of industries, including engineering, architecture, and project management.

1.2 Cracks are divided into the following categories based on their width:

Table-1 Categorisation of Cracks

S. No.	Type of Cracks	Size of Crack
1.	Small Crack	Less than 1 mm
2.	Intermediate Crack	Between 1 and 2 mm
3.	Broad Crack	More than 2 mm
4.	Crazing	It is the occurrence of closely spaced small cracks on the surface of a substance.

II MATERIALS AND METHODS

2.1 About the project: -

This Paper is study of **9 blocks** of a building and each block is **(G+11)** located in Kendriya Vihar, Jaipur.

Fig: -1 Visual inspection of the building.

2.2. Methods of crack detection based on following: -

1.2.1. Destructive test

1.2.2. Non-destructive test

Table-2 Commonly used NDT techniques

Technique	Capabilities	Limitations
Visual Inspection	Macroscopic surface flaws	Small faults are hard to find; there are no underlying problems.
Microscopy	Small surface flaws	No subsurface problems; inapplicable to bigger constructions.
Radiography	Subsurface flaws	Radiation protection has a 2% thickness maximum visible flaw. No surface defects, especially not in porous materials
Dye penetrate	Surface flaws	No surface imperfections, not with porous materials.
Ultrasonic	Subsurface flaws	The material must be an excellent sound conductor.

Magnetic Particle	Surface / near surface and layer flaws	limited capacity to penetrate below the surface, only for ferromagnetic materials.
Eddy Current	Surface and near surface flaws	In certain applications, difficult to comprehend; only applies to metals.
Acoustic emission	Can analyze entire structure	Pricey equipment, difficult to comprehend.

Table-3 Commonly used destructive test

S.No.	Name of test	Use of test
1.	Core testing	To evaluate the strength and characteristics of construction materials, especially concrete and masonry
2.	Load testing	Load testing can be conducted using various methods, depending on the type and size of the structure being tested
2.1	Proof Load Testing	This method involves subjecting the structure to a load that is a percentage of its expected maximum load, typically around 125% to 150% of the design load. The structure is then observed for any signs of cracking or deformation.
2.2	Ultimate Load Testing	This method involves subjecting the structure to a load that exceeds its expected maximum load, until failure occurs. This method is typically used for assessing the ultimate strength and load capacity of the structure.
2.3	Dynamic Load Testing	This method involves subjecting the structure to a series of dynamic loads, such as impact loads or vibrations, to simulate the effects of earthquakes or other seismic events. The structure is then observed for any signs of cracking or deformation.

2.3 Instruments used

As per the site requirements and budget consideration we had used some conventional methods and they found out effective and less costly than other instruments available in market. These sources of equipment, which are listed below, were used in this project effort:

Table-4 Instruments used for this project

S.No.	Name of instrument	Uses
1	Depth Gauge	Usage to gauge depth under a surface serving as a reference. They consist of engineering tools for measuring the depth of holes and indentations from a reference surface as well as depth gauges for underwater diving and related applications.
2	Rebound Hammer	Check the stability and strength of rock formations for geological and geotechnical applications. These distinctive models assess the age, strength, and weathering of rock formations or predict the speeds at which tunnel boring equipment will penetrate the ground.
3	Concrete Cover Meter	A cover meter, also known as a rebar finder, is a gauge used to determine how much concrete is covered by metal pipes and steel reinforcing bars. The diameter of the reinforcing bar (also known as rebar) as well as its depth and placement and orientation may all be determined using the cover meter.
4	Digital Vernier Calliper	High-resolution measurements of an object's breadth or diameter are possible with digital Vernier-type callipers. Final measurements appear on clear LCD panels, eliminating any opportunity for interpretation.
5	Core Cutter	Using a core cutter, it is possible to calculate the dry density of soil and its cohesion. Using core cutters, it is possible to swiftly calculate the soil's density. The void % is determined first. Poor soil compaction is indicated by a high vacancy percentage.

Fig -2 Depth Gauge Ruler

Fig-3 Digital Vernier Calliper

Fig-4 Rebound Hammer Test

Fig: - 5 Ultrasonic Pulse Velocity Meter

Fig-6 Concrete Cover Meter

Fig-7 Core Cutter tool.

III RESULT AND DISCUSSION

3.1 Result of Depth Gauge Ruler.

Table-5 Variation of cracks due to moisture change in Beam

Section Number	Dimension of beam (mm)	Remaining Bar Size (mm)	Crack Width (mm)	Crack Depth (mm)	Comments
1.	304.8*792.48*3048	6.43 30.17	6	1.2	Stirrups bar is originally of 8mm, And main bars are of 32mm. The crack is considered as a broad crack.
2.	304.8*792.48*3048	6.77 31.11	1	0.6	This type of cracks is in the category of small cracks.
3.	304.8*792.48*3048	8.93 29.38	2.5	1.1	This crack is considered as a broad crack.

3.2 Results of Digital Vernier Calliper

Table-6 Digital Vernier Calliper Readings

S. No.	Type of Structure	Original Size of Reinforcement (mm)	Present Size Left (mm)	Comments
1	Column	Main Bar is of 32mm. Stirrups are of 10mm.	Main Bar size is now 30.17mm left. Stirrup's size is varying between 6.43mm to 8.93mm.	The bars are exposed to open atmosphere, there is no proper cover provided at the time of construction also there is seepage of water by which the bars get corroded and their
2	Beam	The stirrups are of 12mm.	Now the stirrups left only 10.04mm.	The stirrups are exposed and there is no cover provided in the beam. Due to seepage of water the bars get corroded and reduced in area.
3	Stairs	The main bars are of 16 mm and 12 mm somewhere.	The 12mm bar left only 9.01 mm, while the 16 mm bar left between 13.62 mm to 14.28 mm.	There is excessive corrosion in the bars. There is no cover provided at the time of construction, so the bars are now exposed and severely damaged.

Fig-8 Staircase with exposed reinforcement

3.3 Results of Ultrasonic Pulse Velocity Meter

Beam (Basement)

Table-7 Result of Ultra Sonic Pulse Velocity Meter for Beam

S. No.	Travel Time (µs)	Travel Speed (m/s)	Dimension (mm^2)	Description
1	109.2	4121	300*450	This shows the strength of the beam is good.
2	138.2	3256	300*450	The velocity is below 3750 m/s, so the concrete quality is doubtful.
3	120.8	3888	300*450	There were not as such much damage to the beam and beam seems to be thoroughly compacted. The velocity lies between 3750 m/s to 4400 m/s, so it is considered of good strength.
4	125.8	3642	300*450	The velocity is below 3750 m/s, so the concrete quality is doubtful.

Table-8 Result of Ultra Sonic Pulse Velocity Meter for Column

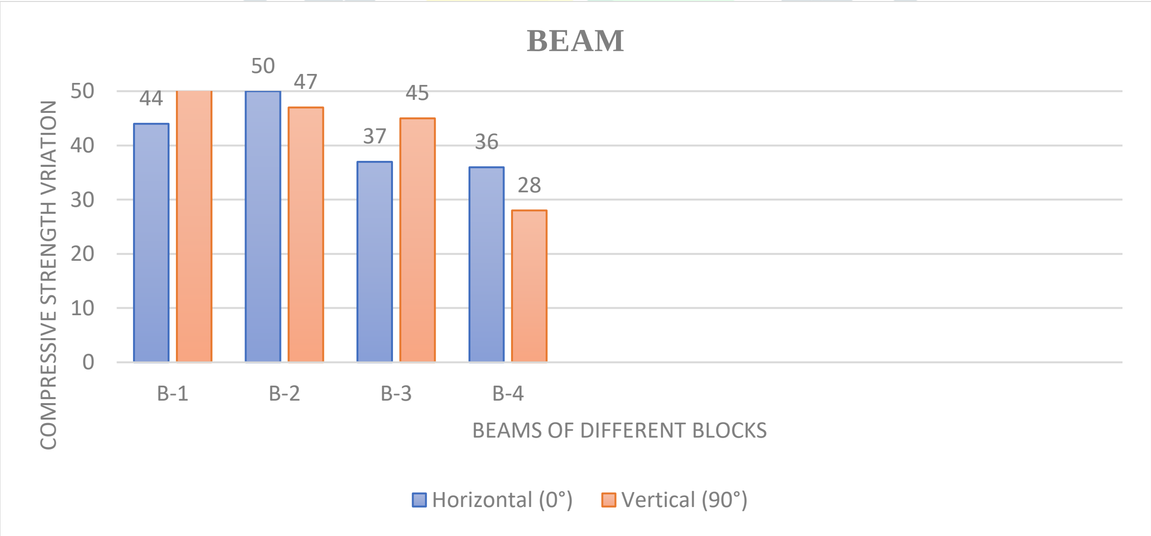
S. No.	Travel Time (µs)	Travel Speed (m/s)	Dimension (ft^3)	Description
1	115.2	3993	1.6*2*9	The velocity is between 3750 m/s to 4400 m/s, so the quality is good.
2	185.7	2477	1.6*2*9	The velocity is below 3000 m/s, so the concrete quality is poor.
3	130.8	3409	1.6*2*9	The velocity is between 3000 m/s to 3750 m/s, so the concrete quality is doubtful.
4	108.7	4406	1.6*2*9	The velocity is above 4400 m/s, so the concrete quality is excellent.

3.4 Results of Rebound Hammer Test

Beam (Basement)

Table-9 Rebound Hammer Test Result

S. No.	Rebound Number		Compressive Strength		Description
	Hz (0°)	Vt (90°)	Hz (0°)	Vt (90°)	
B-1	42	50	44	50	This beam seems to be fine, as there not very much deterioration.
B-2	45	47	50	47	This beam seems to be fine, as there not very much deterioration.
B-3	38	46	37	45	As per the value of horizontal and vertical direction we can say that concrete is in good category.
B-4	37	37	36	28	As per the value of horizontal reading we can say that concrete is in good category. But in vertical direction the quality is fair only.



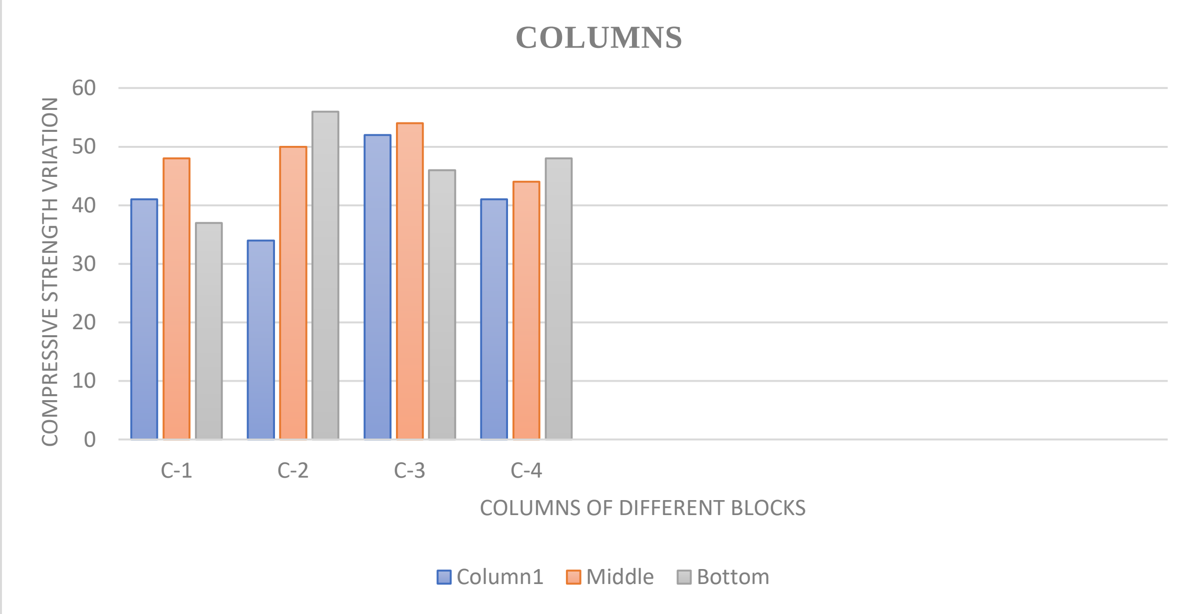
Graph: - 1 Point of Test on Beam v/s Compressive Strength of Beam

Column (Basement)

Table-10 Rebound Hammer Test Results for Column

S. No.	Rebound Number			Compressive Strength			Description
	Top	Middle	Bottom	Top	Middle	Bottom	
C-1	40	44	38	41	48	37	The bottom part of the column is little weaker than the whole column, but still it is considered as good in condition
C-2	36	45	48	34	50	56	The top part of the column is little weaker than the whole column, but still it is considered as good in condition.
C-3	46	47	43	52	54	46	The columns in this block are in excellent condition.
C-4	40	42	44	41	44	48	The columns in this block are in excellent condition.

Fig: -9 Rebound Hammer Testing on Column



Graph: - 2 Point of Test on Beam v/s Compressive Strength of Beam

Retaining Wall (Basement)

Table-11 Rebound Hammer Results of Retaining Wall

S. No.	Rebound Number			Compressive Strength			Description
	Top	Middle	Bottom	Top	Middle	Bottom	
R-1	45	45	47	50	50	53	The Retaining wall in this block are in excellent condition.
R-2	41	42	43	42	44	46	The Retaining wall in this block are in excellent condition.
R-3	41	37	38	42	35	37	There were some defects in Retaining wall and we can categories them as good.
R-4	37	40	39	35	41	39	There were some defects in columns, and we can categories them as good.

Table-12 Rebound Hammer Results of Stairs

S. No.	Rebound Number		Compressive Strength		Description
	Horizontal (0°)	Inclined (45°)	Horizontal (0°)	Inclined (45°)	
S-1	29	52	22	59	This stair of block 1 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-2	27	51	19	57	This stair of block 3 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-3	27	48	19	51	This stair of block 4 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-4	32	55	27	65	As per the value of horizontal reading we can say that This stair of block 5 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-5	31	50	25	55	This stair of block 6 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-6	41	44	42	44	This stair of block 8 is damaged and the lower number is due to that

					the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.
S-7	28	53	21	61	This stair of block 9 is damaged and the lower number is due to that the plastering on the surface is deteriorated due to seepage of water. While the inclined values seem to be excellent.

IV CONCLUSION

4.1 Conclusion from Visual Inspection

- The initial appearance of the building was very bad as there is multiple damage visible.
- Such visuals make the building aesthetically look bad.
- There were cracks in walls, derbies scattered around the blocks, dampness all over the basement section and failed plumbing system.

4.2 Conclusion from the depth gauge ruler

- The depth gauge ruler's findings are listed below. In conclusion, engineers, builders, and building owners can learn a lot about cracks in concrete structures by employing a depth gauge ruler.
- To achieve precision, it's crucial to use the ruler correctly and take measures along the crack several times.
- A professional engineer or contractor with knowledge in concrete repair may need to be consulted if a crack is discovered to be deep or particularly long to assess the damage and decide on the best course of action.

4.3 Conclusion from Rebound Hammer

- From the readings of Rebound Hammer Test 85% Stairs are under the category of below average category, out of which the horizontal part is most severely damaged.
- For the beams of the 9 blocks an average of 44% beams are considered under below average category and needs to be repaired.
- For the columns of the 9 blocks an average of 30% columns are considered under below average category and needs to be repaired.
- For the retaining walls of the 8 blocks an average of 25% walls are considered under below average category and needs to be repaired.

4.4 Conclusions from Ultrasonic Pulse Velocity Meter

- The concrete quality of around 55% of beams are considered as doubtful.

- The concrete quality of around 11% of columns is considered as poor, 22% is doubtful and 55% is good and 12% is of excellent quality.
- The concrete quality of all the stairs, i.e., 100% is poor as there is massive damage in stairs.

V REFRENCES

- SP-25:1984- “Handbook on Causes and Prevention of Cracks in Buildings”.
- [1]Dinesh Harinkhede, [2]Nailesh Rahangdale, [3]Himanshu Darne, [4]Himanshu Meshram,[5]Lalit Jaiwar, [6]Pravin Sahare, 2022. Study on causes and prevention of cracks in building.
- Nama, P. Jain, A. Shrivastava, R. and Bhatiya, Y. 2015. Study on causes of cracks & its preventive measures in concrete structures. International Journal of Engineering Research and Applications, 5(5), pp.119-123.
- [1]S. Raajamurugan, [2]Santhakumar.T, [3]Kalaiyarasan.T, [4]Manikandan.M, 2017. Experimental investigation on causes of cracks in concrete structures and techniques to control the cracks.
- Velumani. P, Muklian. K, Varun. G, Divakar. S, Doss. RM, & Ganeshkumar. P, 2020. Analysis of cracks in structures and buildings. In Journal of Physics: Conference Series (Vol. 1706, No. 1, p. 012116). IOP Publishing.
- Doshi, S., Patel, D., Patel, K.B., Patel, K.B. and Mavani, P., 2018. Methodology for prevention and repair of cracks in building. GRD Journals-Global Research and Development Journal for Engineering, 3(3), pp.52-57.
- Issa, C.A. and Debs, P., 2007. Experimental study of epoxy repairing of cracks in concrete. Construction and Building Materials, 21(1), pp.157-163.
- Pathak, R. and Rastogi, D., 2017. Case Study on Cracks in Public Buildings and their Remedies. International Journal of Science and Research, 6(5), pp.325-329.
- Dr. K. Chandrasekhar Reddy, P. Ashok, et.al. Vol.8, Issue VI, Cracks in Buildings - Generation and Repair Techniques.
- Basu, A. and Aydin, A., 2004, “A method for normalization of Schmidt hammer rebound values,” Int. J. Rock Mech. Mining Sci., Vol. 41, no. 7, pp. 1211-1214
- ASTM C805-02, “Standard Test Method for Rebound Number of Hardened Concrete,” ASTM International, West Conshohocken, PA., USA
- Mirmiran, A. and Wei, Y., 2001, “Damage Assessment of FRP-Encased Concrete using Ultrasonic Pulse Velocity,” Journal of Engineering Mechanics, Vol. 127, No. 2, pp. 126–135.
- IS 3370 Part IV: Code of practice for concrete structures for the restraint of cracks.
- IS 456: Code of practice for plain and reinforced concrete.

IS 13311 Part 1 to Part 8: Non-destructive testing of metals - Ultrasonic